Risk Assessment of *ATLAS HYDROSWEEP DS-2 Hydrographic Deep Sea Multi-beam Sweeping Survey Echo Sounder*

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Abstract

The hull-mounted *Atlas Hydrographic* multibeam deep-sea echosounder *Hydrosweep DS-2* is installed on several research vessels (e.g. *R/V Maurice Ewing, R/V Meteor, R/V Polarstern*) to carry out bathymetric surveys of the sea floor. At full ocean depth (3000 to 11000m water depth), the instrument usually operates in "Deep Sea II" mode. In this mode, three short (24, 12 and 24ms) sound pulses of 15.5 kHz are successively emitted, ensonifying a port-, centre- and starboard beam, respectively. This pattern repeats itself at regular intervals of typically 15 seconds. The resulting swath covers an area of approximately twice the local water depth along the profile line.

The sound pressure level (SPL) capable of causing a temporary threshold shift (TTS) is calculated on the basis of experimentally derived TTS threshold levels and the 3-dB exchange rate, resulting in a critical SPL of 203.2 dB_{RMS} rel. 1µPa. For this calculation, a conservatively estimated effective pulse length of 60 ms, i.e. the sum of the three pulses, is used. Then the corresponding region is derived from the *Hydrosweep DS-2* beam pattern. Again a conservative approach selects the maximum SPL of each of the three consecutive pulses for every direction. The resulting critical region is heart-shaped and bounded by a box of 43 m depth, 46 m width athwartship and 1 m (sic!) width fore-and-aft.

Subsequently, regions where reception of multiple pings could lead to a TTS are determined for increasing numbers of assumed ensonifications. Finally the region where potential critical behavioural responses may occur is determined, assuming a sound pressure level commensurate with results from the Bahamas 2001 stranding event.

For cruising ships (*R/V Polarstern* particularly), the study concludes that the risk of causing a TTS to marine mammals is conservatively estimated to be less then 1% of the risk of a collision between the ships-hull and the animal by comparing the relevant volumes and cross-sections. The risk of causing a permanent threshold shift (PTS) will be smaller, though quantification thereof is difficult. For ships on station (zero velocity), the non-zero risk of ensonifying a marine mammal at TTS levels obviously exceeds the risk of collision, as the latter becomes zero. In this later situation, mitigation methods such as a shut down of *Hydrosweep* on station when whales are observed within a certain mitigation radius could serve to eliminate any remaining risks.